Sounding Science Right: Enhancing Scientific Word Pronunciation and Spelling through SBA among Secondary and Higher Secondary School Students of Rural Bihar.

DR. SHAIL PRAGYA[1], DR. FEROZ AHMAD LONE[2]
[1]A.H.S.N., Sultanganj, Bhagalpur, Bihar
[2]Chief Education Office, District Shopian, J&K

Abstract- This action research explores the improvement of spelling proficiency among elementary school students in a rural school in Bihar. The study draws inspiration from Dr. Feroz Ahmad Lone's unpublished action research conducted in a tribal region of Jammu & Kashmir. While Dr. Lone's study presented impactful strategies, it also faced contextual limitations such as restricted learner diversity and limited generalizability. Building upon his methodology, this study modifies and expands the scope of the intervention to suit Bihar's rural setting. This study extends the duration of implementation to four months and includes a broader student base of 60 learners. A broader range of learners, prolonged implementation, and active collaboration with teachers and parents were integrated to make the spelling instruction more effective. Results suggest that a multisensory and participatory approach can significantly enhance spelling ability and phonemic awareness, especially when adapted contextually to overcome practical constraints. Results indicate substantial gains in students' spelling accuracy, motivation, and engagement, supporting the efficacy of diverse and interactive teaching methods. The research highlights the importance of contextual adaptation in spelling instruction across varied linguistic and cultural landscapes.

Indexed Terms- Scientific Spelling, Pronunciation Improvement, School-Based Assessment (SBA), Rural Education, Phonemic Awareness, Spelling Instruction, Multisensory Learning, Secondary and Higher Secondary Students, Action Research, Bihar Government Schools, Scientific Vocabulary, Mother Tongue Interference, Contextual Learning, Formative Assessment, Educational Intervention.

I.   INTRODUCTION

The ability to spell correctly is a foundational skill in a child's literacy journey. Spelling supports reading, writing, and broader language comprehension. While many methods exist to teach spelling, there remains a need to identify contextually appropriate, engaging, and evidence-based practices, especially in under-resourced rural settings. This paper presents an action research study conducted in Bihar's rural area school to improve spelling proficiency using a blend of techniques adopted and refined from an unpublished action research by Dr. Feroz Ahmad Lone. His study, conducted in a tribal school in Jammu & Kashmir, emphasized phonemic awareness, multisensory techniques, and learner engagement.

Dr. Lone's work provided a strong foundation, but it was constrained by sample size, duration, and generalizability. Recognizing these limitations, this study was designed with wider classroom applicability, diversified student groups, and extended intervention timelines. The goal was not only to replicate successful strategies but to adapt them meaningfully for Bihar's rural learners.

The research focuses on how tailored spelling activities, integrated with phonemic training and supported by family involvement, can bring significant change in early literacy. By refining and contextualizing existing practices, this study aims to offer scalable solutions for spelling instruction in resource-challenged schools.

The focus of this study is on enhancing students' motivation and engagement in spelling and word-work activities at the secondary and higher secondary level, particularly in rural schools of Bihar. In the absence of a standardized district-level curriculum for teaching spelling, the responsibility falls upon teachers to discover and implement effective classroom practices. With this in mind, I aimed to explore how learner choice, participatory methods, and multisensory techniques influence students' ability to become independent and motivated spellers.

Educators widely agree on the importance of spelling proficiency, even though they may differ in instructional approaches. Spelling instruction not only supports accurate writing but also reinforces reading skills by helping learners understand the connection between letters and sounds. Poor spelling ability can hinder both the thought process and clarity of expression in young learners. The need to improve spelling skills in Bihar's rural learners is especially urgent, given their limited access to rich linguistic resources.

This action research is conceptually grounded in the methodology proposed by Dr. Feroz Ahmad Lone in his unpublished study *"Teaching of Word Spelling at Elementary Level in a Tribal School."* His study, conducted in a tribal school in Jammu & Kashmir, demonstrated how structured, phonics-based, and multisensory techniques could improve spelling proficiency among early-grade learners. While the original research was highly effective in its setting, it was limited in scale, grade-level focus, and assessment scope. Inspired by his framework, this study applies an adapted and expanded version of his methodology to a higher academic level — specifically, secondary and higher secondary students in a rural government school in Bihar, with the intention of enhancing spelling retention in scientific terminology.

In Bihar's rural education landscape, students often struggle with the correct spelling of scientific terms, which hinders their academic confidence and comprehension. These challenges are especially acute in schools where learners have limited exposure to English, poor phonemic awareness, and minimal formal instruction in spelling strategies. Recognizing this, the present study integrates spelling instruction with School-Based Assessment (SBA) — a continuous, child-centric, and teacher-led evaluation framework adopted in Bihar under the Samagra Shiksha Abhiyan.

While Dr. Lone's work primarily addressed foundational spelling skills at the primary level, this research builds upon his core instructional strategies — such as sound segmentation, word-building, phoneme manipulation, and spelling games — and tailors them to the linguistic and cognitive level of older students. Moreover, the current study utilizes SBA principles to ensure continuous monitoring, reflection, and adaptation of instruction based on learners' progress.

The SBA framework in Bihar emphasizes formative and diagnostic evaluations integrated within classroom teaching. This research aligns spelling improvement activities within this framework, enabling teachers to track students' performance through real-time, low-stakes assessments such as:
- Syllable clapping exercises
- Root-word decoding logs
- Peer-reviewed spelling relays
- Contextual application of scientific words in content-based activities

By embedding spelling instruction within the SBA ecosystem, the study promotes learner autonomy, teacher flexibility, and curricular relevance. The integration of phonics and morphology-based strategies with contextual vocabulary enhances both retention and scientific comprehension.

Thus, this research aims not only to improve the spelling proficiency of scientific terms among rural learners but also to provide a replicable model that blends Dr. Lone's pedagogical innovation with Bihar's evolving assessment practices. The localized adaptation of his strategies addresses previous limitations — such as narrow sample size, age group, and assessment formats — thereby offering a scalable intervention for rural educational improvement.

Why Does Spelling Matter?
In the context of scientific learning, accurate spelling plays a critical role in reinforcing both conceptual

clarity and correct pronunciation, especially among secondary and higher secondary students in rural areas. Scientific vocabulary is often multisyllabic, derived from Latin or Greek roots, and unfamiliar to first-generation learners. As a science teacher working in a government school in rural Bihar, I have observed that students frequently mispronounce terms like *photosynthesis*, *chlorophyll*, or *respiration*, not due to a lack of understanding, but because of poor familiarity with their orthographic and phonological structure.

Spelling proficiency is not just a mechanical skill; it is a manifestation of deeper linguistic awareness, integrating phonological (sound patterns), orthographic (spelling patterns), and morphological (roots, prefixes, suffixes) knowledge. According to research, students who struggle with spelling often also face challenges in fluently decoding and comprehending scientific texts. Conversely, learning spelling in connection with pronunciation and meaning improves comprehension and confidence in reading science textbooks and answering written questions.

The English language is inherently complex. Its 26 letters represent around 44 phonemes in approximately 250 different ways — a fact that makes both reading and spelling especially challenging for students with limited linguistic exposure. This makes repeated and structured exposure to scientific terms essential, not only for spelling accuracy but also for the development of automaticity — the ability to recognize, pronounce, and write terms quickly and accurately without conscious effort.

By embedding spelling instruction within the School-Based Assessment (SBA) framework, students are offered multiple, low-pressure opportunities to practice these words in meaningful scientific contexts. Activities like relay spelling games, syllable segmentation drills, and oral vocabulary assessments help reinforce spelling through engagement and repetition, while also allowing teachers to monitor and support individual progress.

Research by Weiser & Mathis (2011) has shown that when decoding (reading) and encoding (spelling) are taught together, it leads to significant improvements in phonemic awareness, fluency, comprehension, and vocabulary acquisition. In this action research, these insights are applied specifically to scientific vocabulary, with the belief that spelling instruction — if made contextual, interactive, and SBA-aligned — can be a powerful tool for improving both literacy and scientific learning in rural classrooms.

Certainly! Below is a well-crafted English paragraph based on your observations and intent, which can be used in your research paper's rationale, background, or discussion section. It incorporates your experience of teaching students from classes 9 to 12, the role of early exposure, and the influence of mother tongue (L1) on learning the target language (L2), especially pronunciation and spelling.

The Role of Early Intervention and Mother Tongue Influence in Pronunciation and Spelling:
While teaching science to students of classes 9 to 12 in a rural government school, I consistently observed that many learners struggled with the correct pronunciation of scientific terms. This difficulty was not merely due to a lack of understanding but stemmed from weak spelling skills and limited exposure to English phonetics, often rooted in the influence of their mother tongue (L1). In rural Bihar, most students speak Hindi or regional dialects at home and in their early schooling, and this L1 phonological system strongly impacts their ability to accurately pronounce words in the target language (L2), English. Sounds that do not exist in the native language are either substituted or mispronounced, which, over time, fossilizes incorrect patterns. Through this research, I explored various strategies to improve both spelling and pronunciation, recognizing that such challenges must be addressed not only in secondary education but ideally at the elementary level itself. If students are introduced to accurate phoneme-grapheme relationships and pronunciation practices early on, their transition into scientific English in higher classes becomes smoother. Therefore, early intervention, multisensory spelling instruction, and awareness of L1 interference are crucial in building strong language foundations for rural learners.

Figure 1
The Relationship between Decoding and Encoding Words
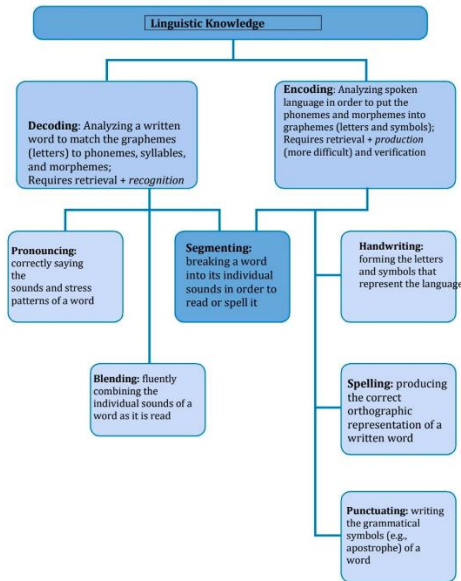
II. METHODOLOGY

School Context and Participants

The research was conducted at Rajkiyakrit Adarsh Uchcha Vidyalaya in Nayagaon, Sultanganj, Bhagalpur, Bihar. The school caters to rural children, with the students of grade 9 to 12. To conduct this action research effectively, I selected a total of 60 students from classes 9 to 12 selected to represent diverse learning levels and balanced gender distribution, comprising 15 students from each grade level. The selection was not random but based on preliminary diagnostic observation and oral assessments, which revealed a consistent pattern of pronunciation errors and spelling difficulties among certain students when using scientific vocabulary. These errors often included mispronouncing multisyllabic terms, incorrect stress patterns, and the substitution of English phonemes with similar-sounding mother tongue equivalents. The identified students represented a cross-section of learners who struggled significantly with decoding and encoding scientific terms during regular classroom instruction.

The purpose of selecting students from different secondary and higher secondary levels was to analyze how spelling and pronunciation issues evolve across grades, and whether a systematic, activity-based intervention could show measurable improvement regardless of age. Since these students were in the formative stage of academic science learning — preparing for board exams and higher education — it was essential to address their language-related academic barriers. The focus on science terms (e.g., respiration, photosynthesis, ecosystem, molecule, reproduction, heredity) was intentional, as mispronunciations at this level often lead to a misunderstanding of core concepts and loss of confidence in both oral and written expression.

Furthermore, the selection of students from a rural government school in Bihar reflects the unique linguistic challenges faced in such environments, where mother tongue influence, lack of exposure to spoken academic English, and absence of structured phonics instruction create deep-rooted spelling and pronunciation issues. This group of students became the core sample for the 120-day intervention program designed using techniques inspired by Dr. Feroz Ahmad Lone's work, combined with SBA-based formative assessment tools. Through continuous monitoring, personalized feedback, and a multisensory learning environment, this research aimed not only to correct surface-level errors but to build a strong foundation in scientific English communication.

Research Planning

This action research followed a pre-test/post-test model rooted in the principles of School-Based Assessment (SBA), with the goal of improving pronunciation and spelling accuracy of scientific and subject-specific terminology among students of Classes 9 to 12. The study was conducted over a period of four months, from July to September 2024, and involved 60 students (15 from each grade) selected based on diagnostic evaluations that identified weak pronunciation skills.

A modified version of the Early Grade Reading Assessment (EGRA) tool was adapted to suit the secondary and higher secondary science curriculum, particularly focusing on complex biological and textbook-based terms. The assessment included three key components:

1. Pronunciation of textbook terms (e.g., "photosynthesis", "organism", "respiration")

2. Spelling of the terms
3. Understanding of meaning through context-based oral use

The intervention was structured around the formative assessment model of SBA, in which weekly activities were carefully planned, executed, and assessed using:
- Teacher observation rubrics
- Peer feedback forms
- Individual pronunciation and spelling journals
- SBA-aligned oral and written test records

Each week, specific pronunciation-focused activities were implemented, including syllable segmentation, word relay games, reading aloud from textbooks, IPA-supported pronunciation correction, and visual + auditory drills. These activities aligned with SBA's focus on continuous evaluation, active participation, and skill reinforcement.

Parental involvement was also integrated as a core part of the SBA framework. Home-based activity kits were provided every month, encouraging parents to participate in spelling and pronunciation exercises with their children. Feedback meetings were held monthly to share progress and provide strategies for continued practice at home.

In addition, collaboration with fellow science teachers ensured uniform implementation of strategies across grades. All educators involved in the intervention were trained to use a common assessment approach, based on SBA tools and shared progress indicators, which helped track student growth systematically and consistently.

By embedding SBA principles into the action research structure, this plan not only facilitated regular monitoring of student improvement but also promoted personalized feedback, peer learning, and community engagement — all essential components in addressing the deep-rooted language learning gaps in rural secondary education.

Action Plan
Research Focus:
This action research is aimed at improving the spelling and pronunciation of scientific terminology among secondary and higher secondary students in a rural school in Bihar, particularly in the context of biology. Inspired by the classroom techniques developed by Dr. Feroz Ahmad Lone, this study expands upon his model by extending the intervention period to 120 days and integrating the framework of School-Based Assessment (SBA) to ensure ongoing formative evaluation.

Target Group:
- Class Levels: Classes 9 to 12 (Science stream)
- Sample Size: 60 students (15 each from Grades 9, 10, 11, and 12)
- School Setting: Government Senior Secondary School, Naigaon, Sultanganj, Bhagalpur (Bihar)
- Language Background: Predominantly Hindi-speaking students with minimal exposure to scientific English vocabulary.

Duration:
- Total Period: 120 days (4 months)
- Phases: Divided into four thematic phases, each spanning 30 days

Phase 1: Diagnostic Assessment & Sound Awareness (Days 1–30)
Objective: Assess baseline pronunciation and spelling ability; introduce phonemic awareness.
Activities:
1. Diagnostic Test – 30 biological terms (e.g., "photosynthesis", "organism", "chlorophyll", "reproduction")
2. Syllable Clapping & Phoneme Mapping – Students clap for each syllable (e.g., *pho-to-syn-the-sis*)
3. "Secret Language" Game – Say scientific terms in sounds (e.g., c-e-l-l) for decoding
4. Pronunciation Practice Using IPA – Teach phonetic spellings (e.g., mitochondria: /ˌmaɪ.təʊˈkɒn.dri.ə/)

Assessment Tools (SBA-aligned):
- Teacher checklist
- Peer observation rubrics
- Audio recordings of student pronunciation (weekly)

Phase 2: Spelling with Meaning (Days 31–60)
Objective: Strengthen understanding of word parts (roots, prefixes, suffixes); integrate meaning and spelling.

Activities:
1. Root Word Dissection – Break terms into morphemes (e.g., "chlorophyll" = chloro (green) + phyll (leaf))
2. Spelling Relay Game – Teams spell and pronounce terms with accuracy and speed
3. Look & Spell with Diagrams – Show labeled diagrams (e.g., human digestive system), ask students to write/spell/pronounce terms.
4. Sound Change Practice – Students change one phoneme to form a new scientific word (e.g., "cell" → "shell")

Assessment Tools (SBA-aligned):
- Written test of scientific roots
- Pronunciation journals
- Observation logs

Phase 3: Contextual Usage & Multisensory Techniques (Days 61–90)
Objective: Improve spelling and pronunciation through visual, auditory, and kinesthetic strategies.

Activities:
1. Walking with Words – Students walk steps for each syllable of a word (e.g., e-vo-lu-tion)
2. Use of Visual Aids – Labeling organs/systems with pronunciation practice
3. Flash Cards + Audio Drills – Use recorded scientific terms for echo drills
4. Mirror Practice – Students observe lip and tongue movement during pronunciation

Assessment Tools (SBA-aligned):
- Pronunciation scoring rubrics
- Scientific spelling bee competitions
- Teacher-student pronunciation conference

Phase 4: Application in Scientific Context & Final Assessment (Days 91–120)
Objective: Transfer spelling and pronunciation skills to textbook reading, writing, and oral presentations.
Activities:

1. Reading Aloud from Science Textbooks – Focus on pronunciation of highlighted terms
2. Scientific Word Dictation – Teacher dictates new biology terms weekly
3. Mini-Presentations – Students explain scientific processes (e.g., respiration) using correct terms
4. Self and Peer Evaluation – Use of SBA checklists to monitor progress

Final Assessment Tools:
- Oral test: 25 scientific words read aloud
- Written test: Dictation of 30 scientific terms
- Self-assessment and reflection journals

Intervention Activities
Weeks 1-4: Foundational Phonemic Awareness
- Name Spelling: Learners practiced spelling their names aloud.
- Look & Spell: Use of drawings and picture cards to connect visuals with spelling.
- Secret Language: Teacher spells words phonetically; students guess the word.
- Sound Positioning: Identifying beginning, middle, and end sounds in words.

Weeks 5-8: Manipulation & Transformation
- Remove & Add Sounds: Students remove or add phonemes to create new words.
- Change the Sound: Replacing initial sounds to form rhyming or new words.
- Game with Dolls: Syllable and phoneme breakdown using toys.
- Hit the Desk: Phoneme counting using rhythmic desk tapping.

Weeks 9-12: Synthesis & Sentence Work
- Hidden Object Game: Spelling clues to guess objects.
- Fast-Slow Game: Pronouncing words quickly and then phonetically.
- Walking with Words: Physical movements to represent phonemes.
- Rhyming Chains: Finding rhymes based on peers' names and classroom objects.

Weeks 13-16: Review, Reinforcement, and Testing
- Weekly spelling bees
- Peer assessment exercises

- Parental quiz sessions at home

Data Analysis

Pre- and post-test results were categorized into four performance levels:

1. No mistakes
2. 1-5 mistakes
3. 6-10 mistakes
4. More than 10 mistakes

Pre-Test Results:

- No mistakes: 8 students
- 1-5 mistakes: 18 students
- 6-10 mistakes: 20 students
- 10 mistakes: 14 students

Post-Test Results:

- No mistakes: 30 students
- 1-5 mistakes: 20 students
- 6-10 mistakes: 8 students
- 10 mistakes: 2 students

Pre-Test Results:

Performance category	Number of students
No mistake	8
1-5 mistakes	18
6-10 mistakes	20
10 mistakes	14

Post-Test Results:

Visual Chart: Student Performance Before and After Intervention

```
| Category      | Pre-Test    | Post-Test                 |
|---------------|-------------|---------------------------|
| No mistakes   | ██          | ████████████████████████  |
| 1-5 mistakes  | ██████      | ██████████████████        |
| 6-10 mistakes | ████████    | ███                       |
| >10 mistakes  | █████       | █                         |
```
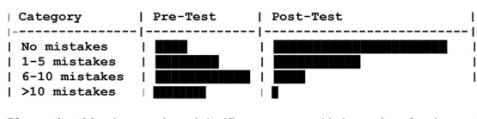
Observation: Most learners showed significant progress, with the number of students making no mistakes increasing nearly fourfold.

CONCLUSION

By contextualizing scientific spelling instruction within the SBA framework and extending the timeline for deeper intervention, this action plan offers a scalable and replicable model for improving scientific language proficiency in rural schools. It aligns with the foundational principles of Dr. Feroz Ahmad Lone's research while addressing its constraints and customizing it to suit the specific challenges faced by secondary students in Bihar's government schools. This extended action research affirms that consistent, engaging, and phoneme-based spelling activities can significantly improve spelling proficiency in rural learners. The interactive and fun-based methods helped in creating a positive learning environment and boosted learner confidence.

RECOMMENDATIONS

1. Extend duration of such interventions to 3-4 months minimum.
2. Train rural teachers in multisensory and phonemic-based spelling strategies.
3. Encourage parental participation to reinforce school learning.
4. Use spelling as an integrated skill with reading and writing.

REFERENCES

[1] Adams, M. J. (1990). *Beginning to read: Thinking and learning about print*. MIT Press.

[2] Bear, D., Invernizzi, M., Templeton, S., & Johnston, F. (1996/2011). *Words their way: Word study for phonics, vocabulary, and spelling instruction.* Pearson.

[3] Carreker, S. (2011). Teaching Spelling. In Birsh (Ed.), *Multisensory teaching of basic language skills* (3rd ed.).

[4] Chall, J. (1967). Learning to read: The great debate. New York, NY: McGraw Hill.

[5] Ehri, L. & Wilce, L. (1987). *Reading Research Quarterly*, 22(1), 47-65.

[6] Fresch, M. J. (2007). Teachers' concerns about spelling instruction: A national survey. Reading Psychology, 28, 301–330.

[7] Gentry, J. R. (2004). *The science of spelling.* Heinemann.

[8] Mahwah, NJ: Erlbaum. Share, D. L., & Stanovich, K. (1995). Cognitive processes in early reading development: Accommodating individual differences into a model of acquisition. Issues in Education, 1 (1), 1-57.

[9] Treiman, R. & Casar, M. (1997). Spelling acquisition in English. In C. Perfetti, M. Rieben

& M. Fayol (Eds.) Learning to spell: Research, theory, and practice across languages (pp. 61-80). Mahwah, NJ: Erlbaum.

[10] Weiser, B., & Mathis, S. (2011). *Reading & Writing Quarterly*, 27(3), 197–226.